COMPLETED
0612
I 49.2:T 75/3
19

Trout Fishing in the U.S.

Report 91-5

December 1996

Addendum to 1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation

U.S. Department
of the Interior
U.S. Fish and
Wildlife Service

NF 97-008210

Trout Fishing in the U.S.

David G. Waddington
Division of Federal Aid
U.S. Fish and Wildlife Service
Washington, DC

and

Andrew Laughland
Division of Economics
U.S. Fish and Wildlife Service
Washington, DC

Division of Federal Aid
U.S. Fish and Wildlife Service
Washington, D.C. 20240
Acting Director, John Rogers
Chief, Division of Federal Aid,
Bob Lange

This report is intended to complement the National and State reports from the 1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. The conclusions are the authors and do not represent official positions of the U.S. Fish and Wildlife Service.

Introduction

Trout fishing is one of the most popular types of fishing in the United States. Thirty percent of all freshwater anglers in the United States fished for trout. In this report we present and discuss trout fishing in the United States and the characteristics of trout anglers. The data used for this presentation come from the 1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (FHWAR). All data represent anglers 16 years of age and older who fished in the United States during 1991. A trout angler is defined as a person who said they fished for trout in freshwater (excluding Great Lakes) at least once during the survey year. They are not persons who fished exclusively for trout. In this report, trout refers to all trout, including rainbow, brown, brook, lake, etc.

The remainder of this paper is divided into four sections. The first section deals with the level of participation in trout fishing in terms of participants and days of participation. This is presented for the nation and on a state-by-state basis. The second section deals with the demographic characteristics of trout anglers and how they compare to the U.S. population and freshwater anglers in total. In the third section we presents a participation model that can be used to describe trout anglers and predict participation in trout fishing. The final section provides a summary.

Trout Fishing Participation Levels

As one of the most popular fish in the United States in 1991, trout were sought after by 9.1 million freshwater anglers, 30 percent of all freshwater anglers (Table 1). In comparison, 12.9 million (42 percent) fished for black bass, 10.1 million (34 percent) fished for panfish, 9.2 million (30 percent) fished for catfish and bullheads, and 8.3 million (28 percent) fished for crappie. Since anglers can fish for more than one species, summing the number of anglers by species will result in a number that is larger than the actual number of anglers. Anglers fished for trout on more than 81 million days for an average of 9 days per angler. Keeping in mind that anglers can fish for more than one species in a day, trout were sought on 19 percent of all freshwater fishing days.

Tables 2, 3, and 4 contain state-by-state estimates of trout fishing. These estimates represent freshwater and trout fishing in each state by residents and nonresidents combined.

The percent of freshwater anglers that fish for trout varied widely from less than 5 percent in low participation states such as Alabama, Florida, Indiana, Kansas, and Mississippi to more than 80 percent in Colorado, Idaho, Montana, Utah, and Wyoming (Table 2). Generally, the Northeastern and Western states had the highest level of participation in

TABLE 1.

Freshwater Anglers and Days of Fishing, by Type of Fish: 1991

(Population 16 years old and older. Numbers in thousands. Excludes Great Lakes fishing.)

Type of fish	Anglers		Days of fishing		Average days per angler
	Number	Percent	Number	Percent	
Total, all types of fish	30,186	100	430,922	100	14
Black bass (largemouth, smallmouth, etc.)	12,857	43	158,226	37	12
Panfish	10,149	34	102,184	24	10
Catfish and bullheads	9,195	30	96,451	22	10
Trout	9,107	30	81,366	19	9
Crappie	8,327	28	90,940	21	11
White bass, striped bass and striped bass hybrids	6,408	21	63,181	15	10
Anything[1]	4,984	17	37,744	9	8
Walleye and sauger	3,278	11	37,302	9	11
Northern pike, pickerel, muskie and muskie hybrids	2,693	9	29,327	7	11
Other freshwater fish	2,550	8	21,452	5	8
Salmon	989	3	8,548	2	9
Steelhead	493	2	4,025	1	8

Note: Detail does not add to total because of multiple responses.

[1] Respondent identified "Anything" from a list of categories of fish.

TABLE 2.

Freshwater Anglers and Trout Anglers, by State Where Fishing Occurred: 1991

(Population 16 years old and older. Numbers in thousands. Excludes Great Lakes fishing.)

State	Freshwater Anglers	Trout Anglers	
		Number	Percent
United States	30,186	9,107	30
Alabama	831	*30	*4
Alaska	213	108	51
Arizona	480	228	48
Arkansas	769	108	14
California	2,118	1,628	77
Colorado	778	706	91
Connecticut	255	175	69
Delaware	45	12	27
Florida	1,311	*46	*4
Georgia	1,066	108	10
Hawaii	32	*8	*25
Idaho	365	319	87
Illinois	1,262	*57	*5
Indiana	928	*26	*3
Iowa	556	*26	*5
Kansas	453	*16	*4
Kentucky	766	39	5
Louisiana	785	48	6
Maine	361	275	76
Maryland	392	87	22
Massachusetts	373	201	54
Michigan	1,305	165	13
Minnesota	1,440	78	5
Mississippi	565	*14	*2
Missouri	1,329	236	18
Montana	342	285	83
Nebraska	252	33	13
Nevada	171	89	52
New Hampshire	267	171	64
New Jersey	411	213	52
New Mexico	281	213	76
New York	1,206	627	52
North Carolina	1,019	183	18
North Dakota	99	*4	*4
Ohio	1,206	126	10
Oklahoma	804	*39	*5
Oregon	605	428	71
Pennsylvania	1,379	876	64
Rhode Island	66	38	58
South Carolina	645	*46	*7
South Dakota	158	30	19
Tennessee	996	148	15
Texas	2,074	*97	*5
Utah	317	263	83
Vermont	181	116	64
Virginia	780	177	23
Washington	681	533	78
West Virginia	339	143	42
Wisconsin	1,339	113	8
Wyoming	301	268	89

* Estimate based on a small sample size.

TABLE 3.

Days of Fishing in Freshwater and for Trout, by State Where Fishing Occurred: 1991

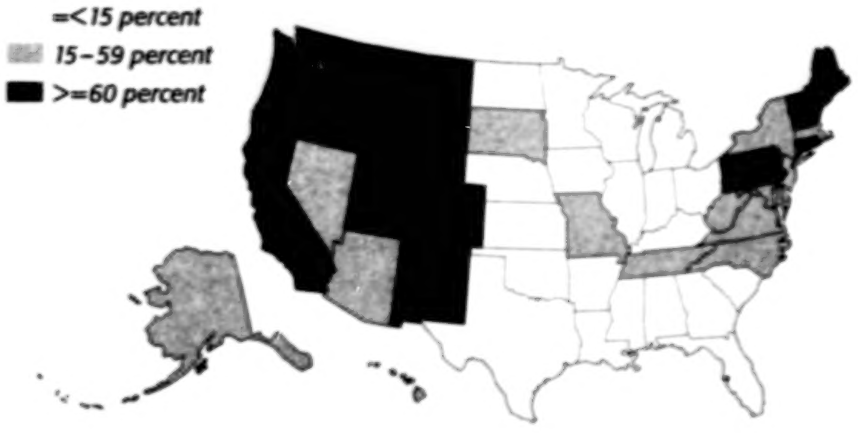
(Population 16 years old and older. Numbers in thousands. Excludes Great Lakes fishing.)

State	Days of Fishing in Freshwater	Days of Trout fishing	
		Number	Percent
United States	430,922	81,336	19
Alabama	11,215	*477	*4
Alaska	2,086	829	40
Arizona	4,074	1,298	32
Arkansas	11,002	624	6
California	18,712	10,140	54
Colorado	6,284	4,815	77
Connecticut	3,460	1,937	56
Delaware	569	54	9
Florida	15,465	*251	*2
Georgia	15,341	642	4
Hawaii	207	*32	*15
Idaho	3,157	2,213	70
Illinois	15,626	*323	*2
Indiana	11,793	*186	*2
Iowa	6,062	*229	*4
Kansas	4,981	*101	*2
Kentucky	9,861	231	2
Louisiana	12,026	383	3
Maine	3,960	2,560	65
Maryland	4,354	1,040	24
Massachusetts	6,011	2,200	37
Michigan	14,816	1,215	8
Minnesota	19,959	652	3
Mississippi	8,338	*105	*1
Missouri	15,136	1,775	12
Montana	3,156	2,188	69
Nebraska	2,734	242	9
Nevada	1,218	678	56
New Hampshire	2,720	1,438	53
New Jersey	5,911	2,250	38
New Mexico	1,943	1,233	63
New York	15,497	5,574	36
North Carolina	13,015	1,568	12
North Dakota	993	*38	*4
Ohio	14,450	839	6
Oklahoma	12,079	*336	*3
Oregon	6,490	2,808	43
Pennsylvania	23,792	11,125	47
Rhode Island	1,049	426	41
South Carolina	9,329	*320	*3
South Dakota	1,722	189	11
Tennessee	13,690	1,039	8
Texas	29,092	*1279	*4
Utah	2,672	2,046	77
Vermont	2,258	1,058	47
Virginia	10,504	1,457	14
Washington	8,583	5,080	59
West Virginia	4,107	1,124	27
Wisconsin	19,003	985	5
Wyoming	2,348	1,720	73

* Estimate based on a small sample size.

FIGURE 1.

Percent of Anglers Who Sought Trout



trout fishing. Southern and Midwestern states had the lowest levels of participation. This can be seen graphically in Figure 1 which shows the percent of anglers who fished for trout.

Columns one and two of Table 3 show the number of days spent fishing in freshwater and fishing for trout, respectively. The third column shows the share of all freshwater days that anglers spent fishing for trout. These days are not necessarily days spent exclusively trout fishing; the anglers could have sought more than one species of fish on a day of fishing. The pattern of days of trout fishing follows that of trout participants with Northeastern and Western states having more days than Southern and Midwestern states.

Table 4 shows the average number of days of freshwater and trout fishing by state. States with the highest average days of trout fishing tended to be the states where trout fishing was most popular such as Connecticut, Massachusetts, and Pennsylvania.

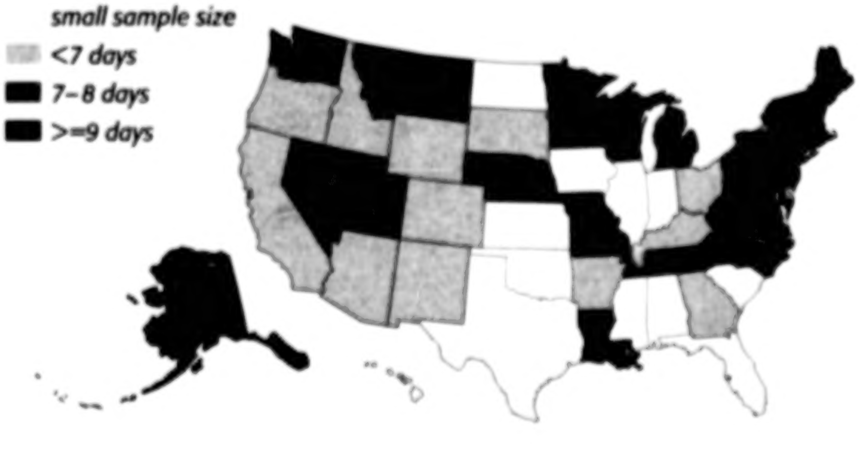
Two exceptions to this are Alabama and Texas. Both of these states had high average days of trout fishing. However, the sample sizes for Alabama and Texas trout anglers were less than 30 which brings into question the reliability of those estimates. This is reinforced by the fact that both Alabama and Texas are better known for their warm water fisheries.

Maryland and Nevada had slightly higher average days of fishing for trout than for all freshwater fish. This is noteworthy considering that a trout fishing day is also a freshwater fishing day. However, it can be explained by the fact that many avid anglers in these states fished exclusively for trout on many of their fishing days. This, combined with the fact that some anglers did not fish for trout at all, explains how the average days of trout fishing can be greater than the average days of all freshwater fishing.

The average number of days anglers spent fishing for trout, by state, is shown graphically in Figure 2. Several states have no marking in them. The sample size for these states was less than 30 so their average days are not included in this figure. The heavily shaded areas show states where the average number of trout fishing days is greater than or equal to 9. Moderate shading represents average days greater than or equal to 7 but less than 9. The lightly shaded states are states where the average days of trout fishing are the lowest, less than 7 days. The geographic distribution in Figure 2 is somewhat similar to Figure 1 which

FIGURE 2.

Average Number of Trout Fishing Days



shows participation rates in trout fishing. The big difference is that some of the western states with high levels of participation had low average days of participation. One explanation for this is that many of the anglers that fish for trout in these states are not avid anglers and that the number of days they fish for trout is low. This would lower the average for the state.

Some of the Midwestern states (notably, Nebraska, Missouri, Wisconsin, and Michigan) had high average days of participation. Similar to the explanation above, these Midwestern states may have high average days of trout fishing because there are few trout anglers but they are avid trout anglers. They fish for trout many days each year thus elevating the average number of days of trout fishing in these states.

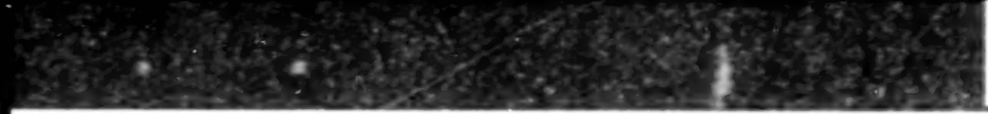
TABLE 4.

Average Days of Fishing in Freshwater and for Trout, by State Where Fishing Occurred: 1991

(Population 16 Years old and older. Excludes Great Lakes fishing.)

State	Average Days Freshwater	Average Days Trout
United States	14.3	8.9
Alabama	13.5	*15.9
Alaska	9.8	7.7
Arizona	8.5	5.7
Arkansas	14.3	5.8
California	8.8	6.2
Colorado	8.1	6.8
Connecticut	13.6	11.1
Delaware	12.6	4.5
Florida	11.8	*5.5
Georgia	14.4	5.9
Hawaii	6.5	*4.0
Idaho	8.6	6.9
Illinois	12.4	*5.7
Indiana	12.7	*7.2
Iowa	10.9	*8.8
Kansas	11.0	*6.3
Kentucky	12.9	5.9
Louisiana	15.3	8.0
Maine	11.0	9.3
Maryland	11.1	12.0
Massachusetts	16.1	10.9
Michigan	11.4	7.4
Minnesota	13.9	8.4
Mississippi	14.8	*7.5
Missouri	11.4	7.5
Montana	9.2	7.7
Nebraska	10.8	7.3
Nevada	7.1	7.6
New Hampshire	10.2	8.4
New Jersey	14.4	10.6
New Mexico	6.9	5.8
New York	12.8	8.9
North Carolina	12.8	8.6
North Dakota	10.0	*9.5
Ohio	12.0	6.7
Oklahoma	15.0	*8.6
Oregon	10.7	6.6
Pennsylvania	17.3	12.7
Rhode Island	15.9	11.2
South Carolina	14.5	*7.0
South Dakota	10.9	6.3
Tennessee	13.7	7.0
Texas	14.0	*13.2
Utah	8.4	7.8
Vermont	12.5	9.1
Virginia	13.5	8.2
Washington	12.6	9.5
West Virginia	12.1	7.9
Wisconsin	14.2	8.7
Wyoming	7.8	6.4

* Estimate based on a small sample size.



Characteristics of Trout Anglers

Freshwater fishing is a very popular activity with nearly 16 percent of the U.S. population over 16 years of age participating in 1991. Thirty percent of all freshwater anglers fished for trout, nearly 5 percent of the U.S. population over 16 years of age. In the following pages we present a comparison of freshwater and trout anglers to the U.S. population by age, sex, education, income, geographic region, and population density of residence. Tables 5 through 10 show the number of trout anglers, freshwater anglers, and U.S. population that are in each category under each of these characteristics.

Tables 5 through 10 also show the proportion of the population that participates in the activity for each category (e.g., what proportion of the 45-54 year old U.S. population participate in freshwater fishing and what proportion of 45-54 year old freshwater anglers fished for trout). The columns labeled "Percent" in tables 5 through 10 show the percent of participants in each activity by category (e.g., what percent of all freshwater anglers were 45-54 years old). Because of the relatively large sample sizes for national estimates, differences in characteristics that are 2 percent or larger are usually statistically significant at the 90 percent confidence level.

Age

Trout fishing appeals to all age groups. Nearly 30 percent of freshwater anglers in all age categories fished for trout (Table 5). However, most trout anglers (53 percent) fall between the ages of 25 and 44. Expanding that age group to 18-54 year olds accounts for 80 percent of all trout anglers.

Comparing the age distribution of trout anglers to the U.S. population shows that trout anglers were younger. Seventy-one percent of trout anglers were less than 45 years of age while only 58 percent of the general population was less than 45. The percent of trout anglers over 54 years old (16 percent) was much lower than the percent of U.S. population in that category (27 percent). Trout anglers had a similar age distribution to that of other freshwater anglers.

Sex

Seventy-seven percent of trout anglers were male. This is disproportionately high compared to the U.S. population, where women were the majority at 52 percent (Table 6). The percent of trout anglers that were male (77 percent) was also higher than the percent of male freshwater anglers (73 percent).

TABLE 5.

Age Distribution of the U.S. Population, Freshwater Anglers, and Trout Anglers: 1991

(Population 16 years old and older. Numbers in thousands. Excludes Great Lakes fishing.)

	U.S. Population		Freshwater Anglers			Trout Anglers		
Age	Number	Percent	Number	Percent	Percent of U.S. Population	Number	Percent	Percent of Freshwater Anglers
U.S. Total	189,964	100	30,186	100	16	9,107	100	30
16-17	6,530	3	1,285	4	20	348	4	27
18-24	23,023	12	3,989	13	17	1,244	14	31
25-34	42,931	23	8,521	28	20	2,575	28	30
35-44	38,341	20	7,303	24	19	2,260	25	31
45-54	27,021	14	4,067	13	15	1,211	13	30
55-64	21,085	11	2,778	9	13	791	9	28
65 and over	31,032	16	2,243	7	7	678	7	30

While many women participated in freshwater fishing (8.1 million), this was only 8 percent of the women in the U.S. Twenty four percent of the male population over 16 years of age participated in freshwater fishing. In addition, women anglers were less likely to participate in trout fishing than male anglers. Women freshwater anglers participated in trout fishing at a rate of 26 percent whereas 32 percent of male freshwater anglers were trout anglers. As a result, women account for 27 percent of freshwater anglers but only 23 percent of trout anglers.

Education

Table 7 shows that nearly one out of every five Americans 16 years old or older (19 percent) had 11 or fewer years of education. Only 13 percent of trout anglers had not completed high school. Seventeen percent of all freshwater anglers fell into this category. Twenty-four percent of trout anglers had 1-3 years of college compared to 19 percent for the U.S. population. The percent of freshwater anglers with 4 or more years of college education was identical to the U.S. population (21 percent). Twenty-five percent of trout anglers had attained 4 or more years of college education.

Freshwater anglers' participation rate in trout fishing increased with education level. Freshwater anglers with less than 12 years of education participated in trout fishing at a rate of 23 percent. Those with 12 years of education participated at a rate of 29 percent. Freshwater anglers with one to three years or four or more years of college education participated in trout fishing at rates of 34 and 35 percent, respectively.

Income

In 1991, 44 percent of the U.S. population 16 years or older lived in households with incomes less than $30,000 (Table 8). The median annual income for all U.S. households in 1991 was slightly more than $30,000. Freshwater anglers had somewhat higher incomes than the U.S. population. Only forty percent lived in households with annual income below $30,000. For trout anglers, an even lower proportion (37 percent) came from households with income below the U.S. median income. Households with incomes above the median accounted for 52 percent of freshwater anglers and 55 percent of trout anglers. Nine percent of freshwater anglers and 8 percent of trout anglers lived in households where the income was not reported.

TABLE 6.

Sex Distribution of the U.S. Population, Freshwater Anglers, and Trout Anglers: 1991

(Population 16 years old and older. Numbers in thousands. Excludes Great Lakes fishing.)

	U.S. Population		Freshwater Anglers			Trout Anglers		
Sex	Number	Percent	Number	Percent	Percent of U.S. Population	Number	Percent	Percent of Freshwater Anglers
Total	189,964	100	30,186	100	16	9,107	100	30
Male	90,369	48	22,041	73	24	6,982	77	32
Female	99,595	52	8,145	27	8	2,125	23	26

TABLE 7.

Education Distribution of the U.S. Population, Freshwater Anglers, and Trout Anglers: 1991

(Population 16 years old and older. Numbers in thousands. Excludes Great Lakes fishing.)

	U.S. Population		Freshwater Anglers			Trout Anglers		
Education	Number	Percent	Number	Percent	Percent of U.S. Population	Number	Percent	Percent of Freshwater Anglers
Total	189,964	100	30,186	100	16	9,107	100	30
0-11 years	35,906	19	5,042	17	14	1,180	13	23
12 years	77,293	41	12,218	40	16	3,483	38	29
1-3 years college	36,725	19	6,507	22	18	2,183	24	34
4 or more years college	40,040	21	6,419	21	16	2,260	25	35

TABLE 8.

Income Distribution of the U.S. Population, Freshwater Anglers, and Trout Anglers: 1991

(Population 16 years old and older. Numbers in thousands. Excludes Great Lakes fishing.)

	U.S. Population		Freshwater Anglers			Trout Anglers		
Household Income	Number	Percent	Number	Percent	Percent of U.S. Population	Number	Percent	Percent of Freshwater Anglers
Total	189,964	100	30,186	100	16	9,107	100	30
Under $10,000	18,585	10	1,795	6	10	410	5	23
$10–$19,900	29,864	16	4,198	14	14	1,139	13	27
$20–$24,900	15,188	8	2,573	9	17	800	9	31
$25–$29,900	18,727	10	3,250	11	17	928	10	29
$30–$49,900	42,689	22	8,793	29	21	2,711	30	31
$50–$74,900	24,448	13	4,744	16	19	1,502	16	32
$75,000 or more	13,579	7	2,195	7	16	846	9	39
Not Reported	26,884	14	2,638	9	10	770	8	29

TABLE 9.

Geographic Distribution of the U.S. Population, Freshwater Anglers, and Trout Anglers: 1991

(Population 16 years old and older. Numbers in thousands. Excludes Great Lakes fishing.)

	U.S. Population		Freshwater Anglers			Trout Anglers		
Region	Number	Percent	Number	Percent	Percent of U.S. Population	Number	Percent	Percent of Freshwater Anglers
Total	189,964	100	30,186	100	16	9,107	100	30
New England	10,180	5	1,186	4	12	784	9	66
Middle Atlantic	29,216	15	2,820	9	10	1,637	18	58
E. North Central	32,188	17	5,553	18	17	590	6	11
W. North Central	13,504	7	3,626	12	27	423	5	12
South Atlantic	33,682	18	4,882	16	14	772	8	16
E. South Central	11,667	6	2,503	8	21	207	2	8
W. South Central	19,926	10	4,039	13	20	447	5	11
Mountain	10,092	5	2,025	7	20	1,595	18	79
Pacific	29,508	16	3,552	12	12	2,651	29	75

At least 27 percent of all freshwater anglers in each income category except for "Under $10,000" fished for trout. Freshwater anglers from households earning less than $10,000 participated in trout fishing at a rate of 23 percent. Freshwater anglers from households earning $75,000 or more had the highest participation rate in trout fishing, 39 percent. The next highest participation rate for trout fishing by freshwater anglers is 32 percent of the $50-$74,900 income category. Freshwater anglers from homes not reporting their income participated in trout fishing at a rate of 29 percent. Fourteen percent of the FHWAR respondents did not report their household income.

Census Geographic Region

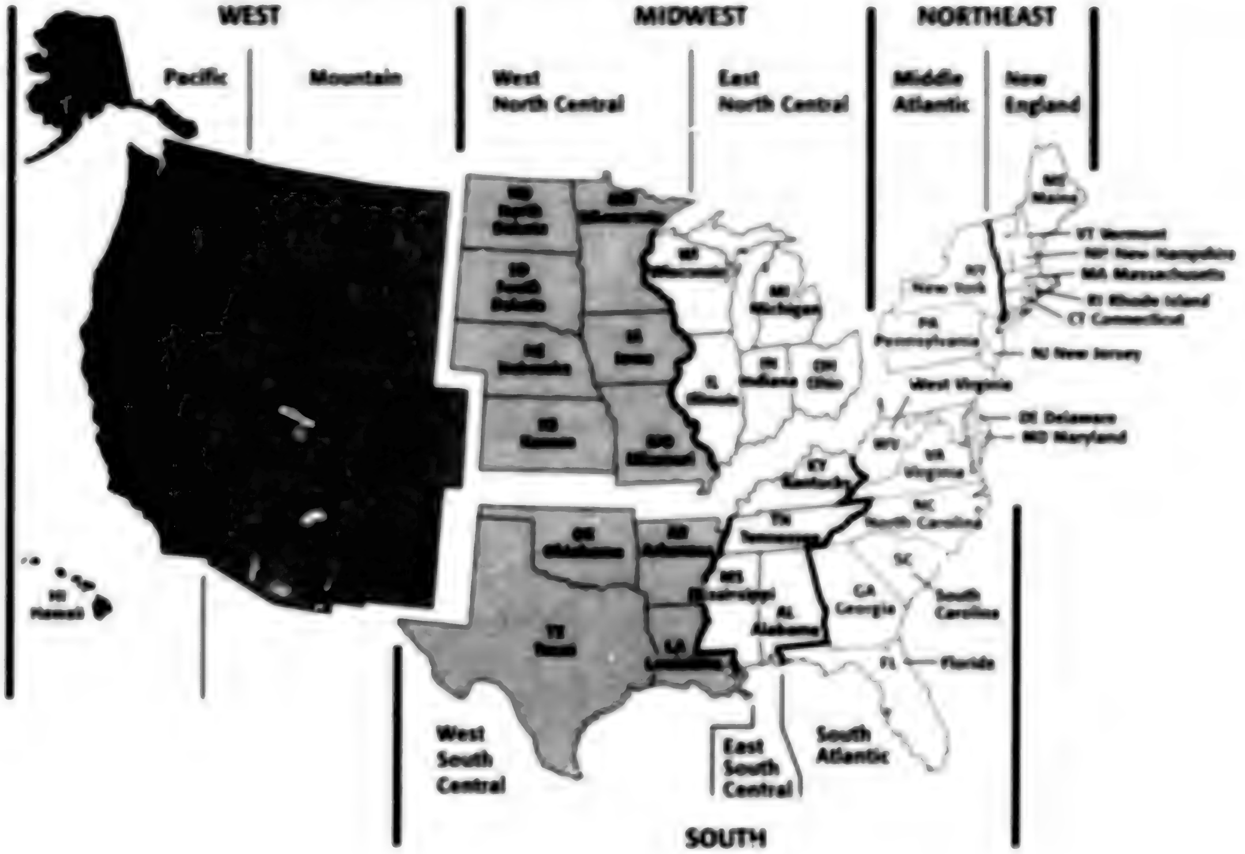
Table 9 shows the distribution of freshwater and trout anglers by Bureau of Census geographic region. Bureau of Census geographic regions are defined in Figure 3. As a percent of the U.S. population 16 years of age and over, the West North Central region had the highest participation rate in freshwater fishing with 27 percent. As a percent of total freshwater anglers, the East North Central and the South Atlantic regions had the greatest number of anglers, making up 18 and 16 percent of freshwater anglers, respectively. The pattern is quite different with trout anglers. Twenty-nine percent of all trout anglers lived in the Pacific region, 18 percent lived in the Mountain region, and 18 percent lived in the Middle Atlantic region. As the state by state analysis suggested, the regions with the lowest share of trout anglers were the Southern and Midwestern regions.

Overall, 30 percent of all freshwater anglers participated in trout fishing. The percent participating by region varied from a low of 8 percent in the East South Central region to highs of 79 and 75 percent in the Mountain and Pacific regions, respectively. The New England and Middle Atlantic regions also had high levels of participation in trout fishing by freshwater anglers at 66 and 58 percent, respectively.

As the participation rates show, the geographic distribution of trout anglers differs from the U.S. population and other freshwater anglers. For example, 18 percent of the U.S

FIGURE 3.

Map of the United States, Showing Bureau of Census Regions



population and 16 percent of the freshwater anglers were from the South Atlantic region whereas only 8 percent of trout anglers were from this region. Similarly, 5 percent of the U.S. population and 7 percent of the freshwater anglers are from the Mountain region whereas 18 percent of trout anglers are from the Mountain region. The largest percent of trout anglers (29 percent) are from the Pacific region which account for only 12 percent of freshwater anglers and 16 percent of the U.S. population.

Population Density of Residence

The 1991 FHWAR asked respondents whether they considered their place of residence to be in a big city or urban area, a small city or town, or a rural area. These categories were *not* defined for the respondent (e.g., by big city we mean "a city with a population of 500,000 or more".) Consequently, one respondent may consider an area to be a small city while another respondent may consider the same area a big city. Therefore, the results discussed below should be viewed from the perspective of where the respondents classified themselves as living and not some generally assigned definition for the size of a big city, small city or rural area.

People in rural areas participated in freshwater fishing almost twice as much as urban residents, 23 percent participation versus 12 percent. Participation in trout fishing by freshwater anglers was similar for rural and small city residents at 29 and 32 percent, respectively. Freshwater anglers from urban areas fish for trout at a much higher rate of 41 percent. However, the total number of trout anglers is largest for the small city category which is how 44 percent of trout anglers describe their place of residence.

TABLE 10.

Population Density Distribution of the U.S. Population, Freshwater Anglers, and Trout Anglers: 1991

(Population 16 years old and older. Numbers in thousands. Excludes Great Lakes fishing.)

	U.S. Population		**Freshwater Anglers**			**Trout Anglers**		
Density of Location	Number	Percent	Number	Percent	Percent of U.S. Population	Number	Percent	Percent of Freshwater Anglers
Total	189,964	100	30,186	100	16	9,107	100	30
Big City/Urban	71,454	38	8,491	28	12	3,511	39	41
Small City/Town	77,405	41	12,533	42	16	3,977	44	32
Rural	39,110	21	9,036	30	23	2,634	29	29
No Response	1,997	1	125	0	6	58	1	46

Participation Model

The descriptive statistics presented in the previous section show how trout anglers differ from freshwater anglers. These descriptive characterizations of anglers have limitations. First, without conducting the appropriate statistical test, it is impossible to determine whether the observed differences between the groups are statistically significant. However, because of the relatively large sample sizes for national estimates, differences in characteristics that are 2 percent or larger are usually significant at the 90 percent confidence level. Second, even if the difference was statistically significant, the isolated effect of the characteristic on an angler's decision to fish for trout cannot be measured. For example, in the general population, income level is correlated with gender. The previous section found participation in trout fishing is also correlated with gender. This raises the question: Were men more likely to have fished for trout because of their gender or because they were more likely than women to come from households with higher income levels? A participation model may be used to analyze this type of question.

The probability of fishing for trout was estimated to predict what sort of angler was most likely to fish for trout and to evaluate the isolated effects of sociodemographic and other factors on that decision. In participation models, the effect of a particular characteristic is calculated in an "other things being equal" context. In the example above, this procedure removes the confounding effects of the correlation between gender and income to show each characteristic's individual contribution to the probability of participation in trout fishing.

The model hypothesizes that a freshwater angler's decision whether or not to fish for trout depends on the angler's sociodemographic characteristics, whether the angler fished more than average, and the region of the country where he or she resides. The dependent variable is one if the angler fishes for trout and zero if he or she does not fish for trout.

This type of yes or no response is modeled in terms of the logarithm of the odds that the individual fished for trout. This is called the logit and appears on the left side of equation 1. Equation 1 shows the model estimated.

$$\ln \frac{P_i}{(1-P_i)} = \alpha + \beta x_i \qquad (1)$$

where:

P_i = Probability that the i-th individual fished for trout

x_i = Vector of explanatory variables

α = Intercept to be estimated

β = Vector of coefficients to be estimated.

The explanatory variables, x, were a combination of binary and continuous variables. They are described in Table 11. The means of the binary variables repeat the percentages reported earlier. For example, 22 percent of trout anglers are women and 23 percent lived in urban areas. The region of residence provides a rough measure of the availability and quality of trout fishing sites. An avidity measure was based on the number of days fished. Using 20 days as the cutoff for determining whether an angler was avid or not was based on the average days per freshwater angler, as reported in the 1991 FHWAR. About 21 percent of freshwater anglers fished 20 days or more.

TABLE 11.

Explanatory Variables in the Trout Fishing Probability Model

Variable	Description	Mean
Income	Annual household income, in thousands of dollars	36.9
Age	Age of respondent, in years	38.8
Urban	1 if respondent indicates urban residence 0 otherwise	0.23
Female	1 if respondent is female, 0 otherwise	0.22
Avid	1 if respondent fished 20 days or more, 0 otherwise	0.28
Northeast	1 if respondent resided in the Northeast,[1] 0 otherwise	0.14
West	1 if respondent resided in the West,[2] 0 otherwise	0.22

1. Northeast includes the Middle Atlantic and New England regions as defined by the U.S. Census Bureau, see Figure 3.

2. West includes the Pacific and Mountain Census regions.

Table 12 shows the coefficients that were estimated from a nationwide sample of 16,395 freshwater anglers. Except for the Age, Urban, and Income variables, all of the explanatory variables were significant at the 1 percent level. The Urban and Income variables were significant at the 5 percent level and the Age variable was not significant.

The likelihood ratio index can be interpreted in a similar way as a multiple correlation coefficient (R^2) in ordinary least squares regression. The index value of 0.58 indicates that the explanatory power of this equation is greater than many recreation models. The equation shows that the probability of fishing for trout increases with income and decreases with urban residence, other things being equal. It also shows that anglers who fish 20 days or more, or live in the West or Northeast have a higher probability of fishing for trout than non-avid anglers in other regions. Women anglers were less likely to fish for trout, other things being equal.

The estimated coefficients do not provide a direct measure of how the explanatory variables affect the probability that a freshwater angler will fish for trout. The coefficients show the effect of the variable on the logarithm of the odds ratio. To get around this, partial derivatives were calculated at the means of the continuous explanatory variables with all dichotomous variables equal to

[1] *Attempts were made in earlier versions of this model to include a supply variable, the surface area of water in the respondent's state of residence. This added no predictive power to the model and was excluded.*

TABLE 12.

Trout Fishing Participation Probability Model

Variable	Estimated Coefficient	Standard Error	Odds Ratio	Partial Derivative
Intercept	–2.0875**	0.0796	–	–
Income	0.0027*	0.0011	1.003	0.0003
Age	–0.0022	0.0015	0.998	–0.0002
Urban	–0.1023*	0.0487	0.903	–0.0101
Female	–0.1513**	0.0494	0.860	–0.0150
Avid	0.5399**	0.0517	1.716	0.0536
Northeast	2.4044**	0.0539	11.072	0.2385
West	3.2652**	0.0534	26.187	0.3239

Pseudo-R^2 = 0.5805

** Significant at the 0.01 level.

* Significant at the 0.05 level.

zero to show how each variable affects the probability of fishing for trout. These partial derivatives shown in Table 12 show a change from a base case of a non urban, non avid, male from the Midwest or Southern region of the U.S. with average income and average age. The derivatives can be used to make statements like "being a woman decreases the probability of fishing for trout by 1.5 percent," or "being an avid angler increases the probability of fishing for trout by 5.4 percent."

Odds ratios show how a unit change in the independent variable changes the odds that an individual participates in trout fishing. The inference is similar to that of the partial derivative. An odds ratio close to one implies no change in the odds of participation from a unit change in the variable. Odds ratios greater than one imply a positive effect on the likelihood of participating in trout fishing and odds ratios less than one imply a negative effect on the likelihood of participation.

The whole equation can also be reevaluated to make more complex comparisons. For example, a woman angler in the South has only an 8.9 percent chance of fishing for trout while an avid fisherman in the West has an 85 percent chance of fishing for trout. Because the model predicts the log of the odds ratio, the calculation of these probabilities is rather involved. A note at the end of this document explains the calculation.

The results show both gender and income have significant impact on the probability of trout fishing. Gender has a stronger influence than income. A $10,000 increase in income increases the probability of participation only three tenths of one percent (0.03% for each $1,000) while the distinction between men and women is 1.5 percent. The univariate analysis showed that people living in small towns and rural areas were more likely to fish but, among anglers, urban dwellers were more likely to fish for trout. The logit equation shows that urban dwellers are less likely to fish for trout when other factors are controlled. This suggests that the univariate result was confounded by interactions between density of population and region, income, or other variables. Earlier observations about regional distributions of trout anglers are confirmed when the other explanatory variables are held constant.

Summary

The 1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation showed that fishing for trout appealed to a large number of freshwater anglers. From a sociodemographic standpoint, there were some interesting differences between freshwater anglers overall and trout anglers. Trout anglers tend to be male, have higher incomes, and live in the Western or Northeastern regions. A trout fishing participation model showed that sociodemographic characteristics had a significant impact on whether an angler sought trout. This model can be used with future population estimates to predict future participation in trout fishing.

These findings from the 1991 Survey underscore the importance of trout fishing for millions of freshwater anglers. Information about who these trout anglers are, their age, sex, where they live, and so on, can be used by recreation planners and managers to develop and refine fishing management programs to enhance the fishing experience of many Americans.

☆U.S. GOVERNMENT PRINTING OFFICE: 1997 - 423-911/50180

Note on Calculating Probabilities of Participation from the Trout Participation Model

Equation 1 (page 14) can be solved for the individual's probability of participation in trout fishing, P_i, as

$$P_i = \frac{e^{\alpha + \beta x_i}}{(1+e^{\alpha + \beta x_i})} \qquad (2)$$

As they appear in both the numerator and denominator of this equation, the interpretation of the coefficients (or "Betas") shown in Table 12 is not direct. An individual's probability of participation can be calculated using the coefficients in Table 12 and a scientific calculator or spreadsheet. Table 13 illustrates the process for the avid fisherman from the West mentioned in the text.

1) First, determine the values you wish to use for each independent variable. The intercept is α and it is constant. For the example, we assume average income, 36.9 (in thousands), and average age, 38.8. The rest of the variables are dichotomous, i.e. equal to 1 if the statement is true and 0 if it is false. Notice that Northeast and West are mutually exclusive; if one is true the other cannot be true. Since we are considering an avid person from the West, the values for Avid and West will be 1 (see Table 13). We assume the person is male and lives in a non-urban area so the values for Female and Urban should be set to 0. Northeast is 0 since our analysis is on a person from the West.

2) Multiply each value by the beta for that variable. The betas are the estimated coefficients reported in Table 12.

3) Sum the results of the calculation in step 2. In the example, this sum is 1.7311. This is the $\alpha+\beta x$ term in equation 2.

4) Take the anti-log of the sum. On most calculators this is the e^x function. In most spreadsheets it is the @EXP(.) function. This is 5.6469 in the example.

5) Calculate P_i as the result of step 4 divided by the sum of 1 and the result of step 4 as shown in equation 2, 0.8496, in the example.

The probability is interpreted as the probability that an angler with the characteristics described by the independent variables will be a trout angler. In this case, the probability that an avid angler who resides in the West will be a trout angler is 84.96 percent.

TABLE 13.

Calculation of Trout Fishing Probability for an Avid Angler from the West

Variable	Beta	Value	Beta x Value
Intercept (α)	-2.0875		-2.0875
Income	0.0027	36.9	0.0985
Age	-0.0022	38.8	-0.0850
Urban	-0.1023	0.0	0.0000
Female	-0.1513	0.0	0.0000
Avid	0.5399	1.0	0.5399
Northeast	2.4044	0.0	0.0000
West	3.2652	1.0	3.2652
Sum ($\alpha + \beta x$)			1.7311
$e^{(\alpha + \beta x)}$			5.6469
Probability			0.8496

U.S. DEPARTMENT OF THE INTERIOR
MARCH 3, 1849

U.S. FISH & WILDLIFE SERVICE

SPORT FISH & WILDLIFE RESTORATION

18

END

05/22/97